

**Growth and Development**

## **Long Run Profit Maximization in Turkish Manufacturing Sector**

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The equilibrium concept is the most important subject for economic theory. The importance of this concept arises in determination of functional structures of the economic variables. Jenkinson (1986) has estimated the long term labour demand function and rationalisation mechanism by using co-integration technique. By focusing on different aspects of rationalisation mechanism in the long run and time series econometrics in formulating and testing this relationship, ACMS (Arrow, Chenery, Minhas, Solow), CES (Constant Elasticity of Substitution) Production Function and co-integration technique are to be employed in this research in particular.

The purpose of this research is to investigate whether the long-run equilibrium implied by profit maximization is valid for the Turkish manufacturing industry for the period of 1950-2001 or not. During this period, Turkish economy has undergone important structural changes, for example the implementation of liberalization policies after 1980s. Thus, the possible effects of economic policy implementation over the profit maximization in the Turkish Manufacturing sector will also be studied by using new time series techniques such as Zivot and Andrews(1992) unit root test and Gregory-Hansen (1996) co-integration tests. Because most of the previous studies about this issue are concentrated in developed countries and there has been little research on Turkish manufacturing sector, this study's contribution is important.

## Introduction

Much of the economics theory is based on equilibrium and optimization concepts. These concepts are the most important issues to test economic theory empirically. These concepts are of great importance in neo-classic theory particularly.

This study will investigate whether the long run equilibrium implied by profit maximization is valid for Turkish manufacturing sector for the period of 1950-2001. In this paper, profit maximization relationship will be constructed by neo-classic labor theory. Therefore, the function to be estimated must include real wage and average labor productivity variables. Empirical analysis will be carried out applying co-integration techniques for real wage and average labor productivity. During this period, Turkish economy has undergone important structural changes, for example the implementations of liberalization policies after 1980s. It is evident that the structure of the variables may be affected by economic policy implementations in this period that caused some structural changes. To understand the possible effects of economic policy implementations over the profit maximization in the Turkish Manufacturing Sector, the methodology of structural break will be employed. A break can change the order of integration of the series. Zivot and Andrews (1992) unit root test and Gregory-Hansen (1996) co-integration tests are the tests that take into account the break in the data.

The paper proceeds as follows. Section one presents the derivation of the profit maximization model to be estimated in the empirical part. Section two includes a brief literature review of profit maximization. Section three sets out the econometric methodology used. The data and empirical results are presented in section four. The empirical analysis showed that co-integrating relationship is failed between wage and productivity in Turkish manufacturing sector.

## Quantitative Methodology

A production function, summarizing the process of conversion of factors into a particular commodity, can be classified in two groups as homothetic and non-homothetic. The main reason of this distinction is whether a constant elasticity substitution is along a ray, expansion path. But our interest is the first one. We can illustrate Cobb-Douglas, CES and VES type of production functions as example of homothetic production functions. Cobb-Douglas is a production function that elasticity of substitution is unity and factor income shares are independent of relative factor prices. CES (Constant Elasticity of Substitution) production function assumes no variable returns and elasticity of substitution through the production surface. VES (Variable Elasticity of Substitution) production function has a variable elasticity of substitution along expansion path. (Meyer and Burley; 1972, Kmenta; 1967 and Wolkovitz; 1969)

The Constant Elasticity of Substitution (CES) Production Functions dominates in applied studies. So we will firstly outline the CES and then Profit Maximization procedure and outline how to go from a production function to a profit maximization relationship. It is illustrated the following model,

$$Q = \gamma (\delta L^{-p} + (1-\delta)K^{-p})^{-\mu/p} \quad (1)$$

In equation 1, L denotes labor, K indicates capital and Q is product. The  $\mu$  parameter is a measure of the economies of scale,  $\delta$  is the share parameter, while p determines the degree of substitution. (Heatfield and Wibe;1987 and Doll and Orazem;1984)

A firm is considered as a production unit that transforms inputs into output and two factors are employed in the production process. L denotes quantity of labor and K is real stock of capital. Identity 2 illustrates this.

$$Q = f(K, L) \quad (2)$$

According to neo-classical formulation, the aim of a firm as a decision-making agent is to maximize profit. Therefore, a firm's problem is to determine the amounts of K and L that maximizes profit. In order to get a useful model in the empirical analysis, the profit function would be considered as equation 3.

$$\pi = pQ(L) - (wL + rK) \quad (3)$$

The profit-maximization goal can easily be illustrated by taking the derivative of the profit function with respect to L. The first condition of profit maximization is the equality of the 4 to zero and in other words, we can move from the equation 3 to identity 5.

$$d\pi/dL = PQ_L - w = 0 \quad (4)$$

$$Q_L = w/P \quad (5)$$

In identity 5,  $Q_L$  denotes marginal productivity of labor and  $w/p$  is real wage. The profit maximization will be realized at the level where the marginal productivity of labor equals to real wage. If we point out that the production function in the equation 2 as a CES Function, the first order condition for profit maximization can be defined as the 6th equation.

$$dQ/dL = ((1-\delta)A^{-p}(Q/L)^{p+1}) \quad (6)$$

If the equation 6 is integrated with 5, the decomposition becomes simply as equation 7,

$$w/p = (1-\delta)A^{-p}(Q/L)^{p+1} \quad (7)$$

Consequently, taking natural logs of both of sides in the equation 7, we derived an early form of the relationship, as equation 8,

$$\text{Log}(w/p) = \text{log}((1-\delta)A^{-p}) + (p+1)\text{Log}(Q/L) \quad (8)$$

and

$$\text{Log}(w/p) = a + v\text{Log}(Q/L)^1 \quad (9)$$

Empirical part of this paper is constructed by taking into account of the last equation.

## Literature Review

Since the mid-eighties, co-integration techniques have become increasingly popular, along with a remarkable amount of work in the time series econometrics, also in calculating labor demand function and measuring profit maximization. The validity of profit maximization condition has usually been tested by using Engle and Granger (1987) two-step method. Jenkinson (1986) and Mc Donald & Murphy (1992) have estimated the long run labor demand function and rationalization mechanism by using co-integration technique. Since Jenkinson's labor demand function failed to verify long run equilibrium, Mc Donald and Murphy verified it with a co-integration vector estimated variables of quantity of labor, capital, output, relative factor price and additionally output effect. Lianos and Fountas (1997) found some powerful proofs on the grounds of long run profit maximization in Greek manufacturing sector by using similar techniques. There are only a few studies on this subject in Turkey. Yamak and Küçükkale (1999) studied 1950-1993 periods and used Johansen co-integration method to test rationalization mechanism in Turkish manufacturing sector. The empirical model in this research based on two variables: real wage and average productivity. They concluded that there is a long run equilibrium relationship between real wage and

<sup>1</sup> This equation is the reverse form of ACMS type CES function and  $v$  represents the  $1/\sigma$ . ( $\sigma$ ) represent the elasticity of substitution, defined as a equation of percentage change in the factor proportion with factor prices is measured by using  $1/(1+p)$  formulation. See. Arrow, K.T., H.B.Chenery, B.S.Minhas and R.M. Solow, "Capital-Labour Substitution and Economic Efficiency", American Economic Review, p: 43, 1961, pp.225-250 and the derivation process of the model to be estimated is taken from Yamak and Küçükkale (1997).

average productivity. Considering Lucas Critique, the studies mentioned above are criticized, because they do not take into account the possible effect of structural break. Some other studies like Boug (1999) have used techniques regarding to break. Considering this critique, this study provides an application of Engle-Granger two-step co-integration methodology and also some advanced techniques with respect to structural break.

### Econometric Methodology

Fundamentally, Granger (1986) identified that regression constructed with non-stationary time series on the other non-stationary series, generates a spurious regression. But, a situation that a regression did not yield spurious relationship as two series was co-integrated is emphasized in latter work by Engle and Granger (1987). For the first condition of co-integration, we have to determine the integration level of series and the most useful and common way to determine the integration order of the series is unit root tests. Three different unit root tests are employed to test the unit root in this study: namely, the ADF (Dickey and Fuller) (1979), PP (Philips and Perron) (1988) and KPSS (Kwiatkowski, Phillips, Schmidt and Shin) (1992) unit root tests. The null hypothesis for the ADF and PP tests is that the series in question has a unit root whereas the KPSS test has the null hypothesis of level or trend stationarity.

Because Turkish economy has undergone important structural changes, we have to analyze effects of structural breaks on integration and co-integration. Structural breaks potentially cause change in the regression parameters of the model. A structural break can change mean value, trend value or both. The conventional unit root tests erroneously fail to reject the null of unit root for the series, in case of a structural break. Perron (1989) first analyzed the impact of structural breaks on the performance of unit root tests. He showed that standard unit root tests, like the augmented Dickey-Fuller (ADF) test, have dramatically reduced power when the underlying process undergoes a structural break. Zivot and Andrews (1992) criticized Perron's assumption of an exogenous date of structural break and permitted the date of the structural break to be endogenously determined within the model. Because policy implementations in Turkish economy may affect the variables those are used in the study. So we considered contribution of Zivot-Andrews to the unit root methodology.

Therefore, the following testing equation is used;

$$y_t = \mu + \beta t + \delta y_{t-1} + \gamma DU_t + \theta DT_t + \sum_{i=1}^k \eta_i \Delta y_{t-i} + \varepsilon_t \quad (10)$$

In this methodology,  $TB$  (the time of break) is chosen at the point that minimizes the one-sided  $t$ -statistic of  $\delta = 1$  in equation 10.  $DU$  and  $DT$  are dummy variables that capture a break in mean and slope occurring at time  $TB$ , respectively. As  $TB$  is the break date, and  $DU = 1$  if  $t > TB$ , and zero otherwise,  $DT$  is equal to  $(t-TB)$  if  $(t > TB)$  and zero otherwise. The null is rejected if the coefficient is statistically significant.

To determine the long run relationship between  $Lwr$  and  $Lqr$ , Engle-Granger co-integration method will be employed. The Engle-Granger test has two steps: First estimate the co-integrating regression (in equation 11) that specifies the long-run equilibrium between variables.

$$Lwr_t = c + a Lqr_t + e_t \quad (11)$$

At the second step,  $e_t$  is tested for stationarity. If  $e_t$  is stationary, the null hypothesis of no co-integrating relationship between  $Lwr$  and  $Lqr$  is rejected.

The conventional approach of co-integration assumes that co-integration vectors are time invariant. Gregory and Hansen (1996) is an extension of the Engle-Granger test where a unit root test is applied to the residual error from an OLS regression of a co-integrating equation that directly incorporates with the structural break. For that reason, the alternative

hypothesis is that residuals do not contain a unit root and hence there is co-integration with a single unknown break, since the null hypothesis of Gregory-Hansen tests is similar as Engle-Granger method. To test for co-integration in the presence of an unknown structural break, we used the co-integration tests suggested by Gregory-Hansen. There are three types of structural break in Gregory and Hansen approach, a shift in intercept (12), in trend (13) and in both (14) of the co-integrating vector. Gregory-Hansen considered three models allowing structural change in the co-integrating relationship. These models are as follows:

**Model 1: Level shift (C)**

$$y_{1t} = \mu_1 + \mu_2 \cdot \phi_{t\tau} + \alpha^T \cdot y_{2t} + e_t, \quad t=1,2,\dots,n \quad (12)$$

$y_{1t}$  and  $x_t$  in the context of our analysis, are the Lwr and Lqr respectively. The dummy variable  $\phi_{t\tau} = 1$  if  $t > [n\tau]$  and 0 otherwise, where the unknown parameter  $\tau \in (0,1)$  denotes the (relative) timing of the change point, and  $[ ]$  denotes integer part.

**Model 2: Level shift with trend (C/S)**

$$y_{1t} = \mu_1 + \mu_2 \cdot \phi_{t\tau} + \beta t + \alpha^T \cdot y_{2t} + e_t, \quad t=1,2,\dots,n \quad (13)$$

**Model 3: Regime shift (C/T)**

$$y_{1t} = \mu_1 + \mu_2 \cdot \phi_{t\tau} + \alpha_1^T \cdot y_{2t} + \alpha_2^T y_{2t} \phi_{t\tau} + e_t, \quad t=1,2,\dots,n \quad (14)$$

For each  $\tau$ , above models are estimated by OLS, yielding the residuals  $e_t$ . From these residuals, the ADF test statistics and the Phillips' (1987) test statistics  $Z_\alpha(\tau), Z_t(\tau)$  are estimated. The breaking point is where the minimum ADF,  $Z_\alpha(\tau)$  or  $Z_t(\tau)$  statistics is acquired. Next, the null hypothesis of no co-integration is tested by using the smallest values of these statistics in the possible presence of breaks.

## Empirical Results

### Data

The data set used for the empirical analysis in this paper consists of annual observations extending from 1950 to 2001 on real wage (Lwr) and average labor productivity (Lqr) in the manufacturing sector. The real wage is measured by taking into consideration the identity of payment to employee in the manufacturing sector / total employee and the identity of total value added in manufacturing sector / total employee is used by measuring average labor productivity. Both Lwr and Lqr are measured in real terms and deflated by producer price index. All variables are expressed in TL. Data are obtained from Turkish Statistical Institute (TUIK) and from the Statistical Indicators, 1923-2001.

### Unit Root and Co-integration without Break

The first step for co-integration analysis is to test for unit root of the series. There are different tests for unit roots described in the literature. We employed ADF, PP and KPSS tests for checking non-stationarity assumption. Table 1 reports the results of various unit root tests developed by Dickey-Fuller (ADF), by Phillips- Perron (PP) and KPSS (Kwiatkowski, Phillips, Schmidt and Shin). The results are consistent with Real Wage (Lwr) and Average Labor Productivity (Lqr) being integrated of order one,  $I(1)$ . This situation indicates a difference stationary process (DSP). But the KPSS and other tests results are in conflict in some extent. The KPSS tests some of results signs integration level of series as  $I(0)$ . Different unit root test results are likely to show us a sign for structural break.

**Table.1 Unit Root Tests Results**

	Lwr		Lqr	
	Trend	No Trend	Trend	No Trend
ADF	-3.461*(1)	-1.644*(1)	-2.957*(1)	-0.768*(0)
PP	-2.221*(0)	-1.376*(2)	-2.514*(4)	0.753*(10)
KPSS	0.071*(5)	0.944(5)	0.065*(4)	0.912(5)

Note: \* denotes unit root at 5% significance level; numbers in parenthesis are optimum number of lags determined according to AIC; critical values are based on MacKinnon (1991). For PP and KPSS tests, numbers in parenthesis are the truncation lag determined according to Bartlett Kernel.

Granger (1981) and Engle and Granger (1987) demonstrated that, if a vector of time series is co-integrated, the long-run parameters can be estimated directly without specifying the dynamics because, in statistical terms, the estimated long-run parameter estimates converge to their true values more quickly than those operating on stationary variables. The tests procedure depends on whether the disturbances are stationary or not.

In brief, our variables satisfy the first condition of the Engle-Granger co-integration method, (they are integrated of the same order). The estimation results of the long run Engle-Granger model are given in the Table 2. Having established that two series under examination are I(1) process, Engle-Granger two stage procedure is postulated. According to Engle-Granger co-integration test result, showed in table 2, there is no co-integration vector between Lqr and Lwr, which means that the profit maximization is not valid for Turkey Manufacturing Sector in the period.<sup>2</sup>

**Table. 2. Co-integration Tests Results**

$Lwr_t = \beta_1 + \beta_2 Lqr_t$		
$\beta_1$		$\beta_2$
1.348*		0.724*
R-Squared = 0.9094		CRDW=0.3969
<b>ECM (Error Correction Mechanism)</b>		
$\Delta Lwr_t = \alpha_0 + \alpha_1 u(-1) + \alpha_2 \Delta Lqr_t + \text{lagged} \Delta Lwr_t$		
$\alpha_1$	$\alpha_2$	k
-0.164**	0.468	1
<b>ADF</b>		
-3.0287 (1)**		

Note: \* denote the rejection of the null hypothesis and \*\* denote the not rejection of the null hypothesis at 5% level respectively. Critical value are based on MacKinnon (1991) and at 5% significance level are -3.4966; models include constant and no trend;  $k$  is the lag length used in the test for each series and number of lags are determined according to the AIC and given in parenthesis.

### The Structural Break, Unit Root and Co-integration

Perron (1989) admitted the possibility of structural breaks in the series and suggested that the conventional unit root test could fail to reject the unit root hypothesis of non-

<sup>2</sup> Because  $u$  (error term obtained from long run equation) checked for stationarity, it is seen that  $u$  has unit root when  $\alpha=0,05$  or  $u$  is found as I(1). To test for co-integration error-correction models are fit to the model under study too. As a proof of no co-integration, we can see that the parameter of  $u(-1)$  in Error Correction Model is not significance.

stationarity even for series known to be trend stationary with structural break. Zivot and Andrews (1992) criticized Perron's assumption of an exogenous date of structural break and permitted the date of the structural break to be endogenously determined within the model.

Standard ADF tests have revealed the real wage and average labor productivity series in Turkey to be  $I(1)$ , this paper has questioned this result by permitting one endogenously determined break by using Zivot-Andrews unit root test considering the results of structural change on the ADF test statistic. Table 3 summarizes the result of the Zivot-Andrews test in the presence of structural break allowing for a change in the intercept and trend.

**Table.3 Zivot-Andrews Endogenous Break Test Results**

	<i>Lwr</i>	<i>Lqr</i>
<i>TB</i>	1981	1980
$\delta$	-0.4288 (-4.0262)	-0.5028 (-4.3188)
$\theta$	-0.1355 (-3.1380)	0.3321 (4.1038)
$\gamma$	1.0042 (1.8909)	-1.6478 (-2.4306)
$\beta$	-0.0091 (-0.5104)	0.0214 (1.0024)
<i>k</i>	0	1

Note: Critical values at 1%, 5% and 10% significance level are -5.57, -5.08 and -4.82 respectively (Zivot ve Andrews, 1992). *k* is the lag length used in the test for each series and selected criteria based on AIC. t statistics of the related coefficients are given in parenthesis.

Specially, in our case, the models of Zivot-Andrews were estimated over period from 1950-2001. Each time the appropriate dummy (DU, DT) was employed. The results presented in table, report the minimum t statistics and their corresponding break times. Considering structural breaks in all series, the two variables are found to be  $I(1)$  or real wage and average labor productivity series are difference stationary with one endogenous break. In other words, the results from the Zivot-Andrews test confirm the results from the other tests that all series are  $I(1)$ . According to Table 3 break points seems to coincide 1980 for Average Labor Productivity the year after Turkish Military Coup in 1980, the social rights and wage were restricted in large extent and after the liberalization program and break points seems to coincide 1981 for real wage the year which it, low real wage, is one of the main subject of policy implementations. The main empirical results of this model is that we find general evidence for structural breaks, particularly trend break, causing downward-sloping real wage and upward-sloping average labor productivity during or after in 1980's.

Secondly, we investigate co-integration with break. The power of Engle-Granger test substantially decreased, when there is a break in the co-integrating relationship. To overcome this problem, Gregory-Hansen extended the Engle-Granger test to allow for breaks in either the intercept or the intercept and trend of the co-integrating relationship at an unknown time. As stated by Gregory-Hansen, their testing procedure is of special value when the null hypothesis of no co-integration is not rejected by the conventional tests. Our Engle-Granger test results does not sign a co-movement between our variables, and the possibility of structural break in error term should be used the Gregory-Hansen test to be able to effects of break on co-integration.

**Tablo.4. Gregory-Hansen Structural Break Test Results**

Model	ADF	TB	$Z_t^*$	TB	$Z_\alpha^*$	TB	k
C	-4.994*	1983	-3.722	1983	-24.383	1983	2
C/T	-5.481*	1983	-3.800	1983	-25.798	1983	2
C/S	-5.050*	1983	-3.724	1983	-24.332	1983	2

Note: Critical values at 1%, 5% and 10% significance level are -5.96, -5.72 and -6.45 & -79,65, -68,43 and -63,10 for  $Z_a$  respectively (Gregory and Hansen, 1996). \* imply that the not rejection of the null hypothesis in the possible presence of breaks at 1%, 5% and 10%, respectively.

The results of the Gregory-Hansen test are represented in Table 4. According to these results, the standard and conventional co-integration approaches have similar results. All models report that the no co-integration is present with a break point at 1983. Consequently, there is no doubt that there is not long run equilibrium between real wage and average productivity due to structural breaks.

### **Conclusion**

This study aims to investigate whether the long-run equilibrium implied by profit maximization is valid for the Turkish manufacturing industry covering the period of 1950-2001. In this period the Turkish economy has experienced important policy changes.

When the rationalization mechanism is tested by Engle-Granger method, no co-movement was found between real wage and average labor productivity. This indicates evidence against neo-classic theory of adjustment between our variables or there is no link between real wage and average labor productivity. Gregory-Hansen indicated that when a shift in parameters takes place, Engle-Granger test may be failed. So the structural break in the co-integration equation is importance in terms of rationalization. In addition to Engle-Granger, Gregory-Hansen test rejected the co-integrating relationship.

The empirical analysis showed that co-integrating relationship is failed between wage and productivity in Turkish manufacturing sector. According to our results, the breaks caused by implementations of 1980's, the period that Turkey could grow at labor productivity and a fall in real wages, affect of co-integration or profit maximization mechanism. Other studies about this issue are concentrated in developed countries and there has been little research on Turkish manufacturing sector, this study would show how policy implementations and 1980's as a period affect the relationship and parameter.



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